

RAMSES-CH: A New Chemodynamics Code

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Abstract. We present a new chemodynamical code based on the adaptive mesh refinement code RAMSES. The new code uses Eulerian hydrodynamics and N-body dynamics in a cosmological framework to trace the production and advection of several chemical species. It is the first such code to follow the self-consistent evolution of chemical elements in cosmological volumes while maintaining sub-kiloparsec resolution. The code will be used to simulate disk galaxies and explore the influence of chemical evolution models and star formation on galactic abundance ratios.

There are numerous cosmological codes on the market but studies of chemical evolution (CE) are limited to smoothed particle hydrodynamics with a dearth of Eulerian implementations that include a detailed chemical evolution model. With the aim of providing a complementary approach to existing CE codes we present a fully cosmological, CE code with an adaptive mesh refinement hydrodynamics scheme that traces the formation and subsequent evolution of H, He, C, N, O, Ne, Mg, Si and Fe. The model presented here uses a Kroupa et al. (1993) initial mass fraction (IMF) and a SNIa delayed time distribution inspired by Kawata & Gibson (2003). Stellar lifetimes are taken from Kodama & Arimoto (1997), SNIa yields from Iwamoto et al. (1999), SNII yields from Woosley & Weaver (1995) and AGB stellar wind yields from van den Hoek & Groenewegen (1997).

Results

Our code is applied to cosmological simulations of disk galaxies achieving a resolution of 436 pc. The galaxy presented is a field spiral galaxy of total mass $6.8 \times 10^{11} M_{\odot}$. This galaxy will be used as a fiducial model for a series of test runs using different IMFs and SNIa models to ascertain the influence that each of these ingredients has on the abundance ratios, metallicity gradients, morphology and kinematics of the galaxy. A degree of success is achieved in fitting observations of the Milky Way disk (however we stress that this galaxy is by no means a Milky Way clone) but most parameter combinations are too α -rich at the high metallicity end of the distribution. It is believed that this can be traced to the relatively low SNIa rate and future runs will explore this in more detail.

Summary

We present the first of what will become a suite of Eulerian cosmological disk galaxy simulations with CE and sub-kpc resolution. The first simulations show a good agree-

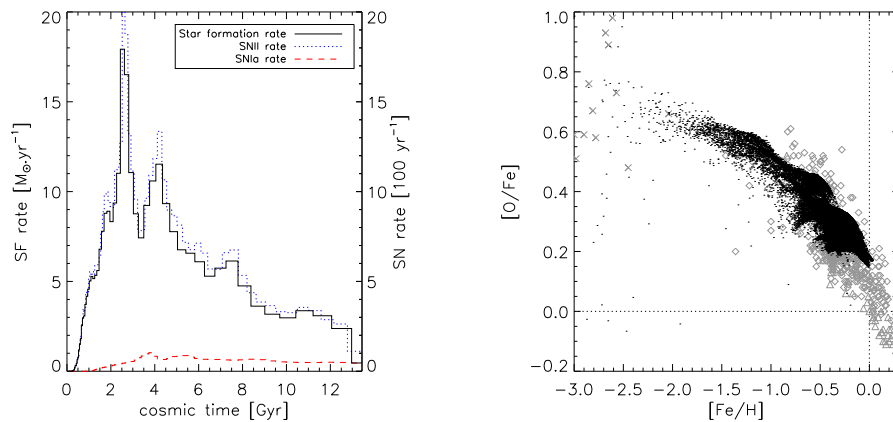


Figure 1. Star formation and SN rates (left panel). The $z=0$ SN rates are $\text{SNII}=0.763 \text{ SNuM}$ and $\text{SNIa}=0.096 \text{ SNuM}$ (SN per century per $10^{10} M_{\odot}$) and compare favourably with those observed by Mannucci et al. (2008) of $0.65^{+0.16}_{-0.13} \text{ SNuM}$ (SNII) and $0.14^{+0.5}_{-0.04} \text{ SNuM}$ for (SNIa) in field Sbc/d galaxies. An example of [O/Fe] vs. [Fe/H] (right panel) for the particular CE model used in this run. Observational data is plotted in grey, Cayrel et al. (2004) (crosses), F/G/K dwarfs from Ramírez et al. (2007) (diamonds) and solar neighborhood F/G stars from Bensby et al. (2004) (triangles).

ment of the SN rates with observations and an improved rotation curve with respect to their counterparts created with the standard feedback mechanism. A great deal of variation in abundance ratios is seen under changes in initial mass function slope, upper mass limit and SNIa delayed time distribution. Future work will explore a full range in parameter space to constrain the CE of disk galaxies.

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